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IMPROVEMENT OF THE TECHNOLOGY FOR THE ENRICHMENT OF KAOLIN-CONTAINING ORES

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Abstract
The issue of the quality of finished products of JSC Novokaolin GOK is considered. The chemical composition and physicochemical indicators of the ore are studied. It is determined that the raw material contains a significant content of iron and titanium, which adversely affects the quality of the final products.

The effect of classification operations on hydrocyclone and wet magnetic separation on beneficiation indices was studied. Previously, an analysis of the granulometric composition of the submitted samples was performed. From the results of the sieve analysis of the initial samples of the Eleninskoye deposit, it can be seen that a significant part of the material is -0.04+0.02 mm. Analyzing the results of the separation of kaolin clay samples on a laboratory hydrocyclone, it can be concluded that the efficiency of the process is quite high, which is proved by the ability to isolate a sand fraction with a particle size of more than 0.04 mm. The results obtained indicate that the coloring pigment - iron oxides - is emulsified or is located in a crystal lattice. The results of the chemical, granulometric compositions and whiteness of the hydrocyclone plums of the Eleninskoye deposit samples indicate the possibility of obtaining enriched kaolin of standard grades. Recommendations are given for improving the ore beneficiation scheme of the Eleninskoye deposit in order to transition the enterprise to continuous excavation of ores and improve the quality of kaolin whiteness. Keywords: kaolin, Eleninskoye deposit, beneficiation, particle size characteristic, magnetic separation, classification, hydrocyclone, whiteness.

Introduction To date, there is a high growth of the ceramic industry in Russia. Kaolins are one of the most important raw materials necessary for the production of ceramic products and building materials. Their properties provide the main technological characteristics of raw materials and finished products. 12-15% of the consumption of enriched kaolins is 400-500 thousand tons per year, the rest of the raw materials are currently imported. Large deposits located on the territory of the Russian Federation are concentrated in the Urals, they belong to the Ural-Mugodzhar kaolin-bearing province, which stretches along the entire eastern slope of the Urals. After the bankruptcy of Ksanta CJSC, which processed kaolins from the Kyshtym

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deposit, the main kaolin producers were Novokaolin GOK JSC, which is developing the Eleninskoye kaolin deposit, and Plast-Rifey LLC, which extracts kaolin from the Zhuravliny Log deposit. Among the manufacturers, it is also worth noting Borovichi Refractory Plant JSC, which uses kaolins in the production of refractories, but in recent years, the company has significantly reduced the production of fireclay products and powders and, accordingly, the volume of production of its own kaolin. In 2020, the annual production of kao lin at Novokaolin GOK amounted to 60 thousand tons of enriched kaolin with the design capacity of the enterprise of 75 thousand tons per year. It should be noted that the enterprises operating these deposits do not carry out deep enrichment of kaolins, limiting themselves to the selective extraction of kaolin suitable for sale in its natural form or processed according to schemes based on the production of two marketable products — kaolin and sand — due to classification operations by size. Such an approach to the processing of raw materials leads to the formation of a significant number of dumps-warehouses from low-grade raw materials, which are not currently being processed. The task of the research is to improve the existing technology by involving low-grade raw materials in processing. The need to solve the problem of processing low-grade kaolin raw materials with the production of conditioned products is associated with the constantly increasing demand of various industries for kaolin raw materials. And if in the paper and rubber industries there is a possibility of switching from kaolin to microcalcite as a filler, then the unique viscosity properties of kaolin do not allow to abandon it in the production of ceramics and refractory raw materials, the production of which is increasing every year. The research methods given in the work were carried out on kaolin ore from the Eleninskoye deposit. To solve the tasks, a set of research methods was used: microscopic study of sections on the solid state analyzer Mineral C7; to study the material composition, the chemical method, the thermogravimetric method on the STA synchronous thermal analysis device by NETZSCH and X-ray diffraction analysis on the SHIMADZU XRD-6000 diffractometer were used; To determine the optimal technological parameters of separation, experiments were carried out on laboratory installations (crushers, mills, screen, hydrocyclone and magnetic separator). Results and discussion of the results of the Kaolin Eleninskoye deposit is located in the Kartalinsky district, 0.5 km southeast of the village of Novokaolinovoye, Chelyabinsk region. The deposit is confined to the weathering crust of microcline granites of the Dzhabyk-Karagay massif. The primary Eleninsky kaolins were formed on the basis of feldspar-containing rocks of the deposit. Their clay component is practically monomineral, it is represented mainly by kaolinite, minerals of the hydromica group are contained in small quantities (kaolins include insignificant impurities of alkalis). The clays included in the productive strata are represented mainly by white kaolins, some of the rocks are densely colored with iron hydroxides, which is why their color has changed to light yellow, yellow, ochre-yellow or pink. Representative samples were taken at the Eleninskoye field. The obtained material for study was subjected to the study of the chemical composition and physicochemical indicators, the results are presented in Table 1. 1 and 2. From Table 1. 1 and 2 show that there is a significant content of iron and titanium in the studied material, which adversely affects the quality of the final products. The results of mineralogical analysis of the samples show that the main ore minerals in the sample are native

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iron and spinels with the general formula AM2 O4, where A is Mg2+, Zn2+, Mn2+, Fe2+, Ni2+, CO2+; M — Al2+, Mn3+, Fe3+, V3+, Cr3+, Ti4+, enclosed in a silicate matrix, martite is represented in a subordinate state. The size of spinel inclusions in intergrowths ranges from 2 to 30 μm. At the same time, it should be noted that spinel grains are not found in free form, when the silicate matrix is destroyed, the process of replacing magnetite with hematite begins, leading to the formation of martite grains. This phenomenon is typical only for grains with a grain size of more than 10 μm. The absence of large grains of minerals in the sample is due to the fact that the deposits of low-grade clays are confined to the zone of hematite-containing mylonites and have largely undergone weathering processes. An analysis of the practice of beneficiation and the state of the industry shows that the low cost of finished enriched kaolin and the complexity of its processing schemes in the event of contamination with coloring impurities impose restrictions on the use of operations that significantly increase the cost of enriched kaolin. As a result of beneficiation, a product is obtained that does not always meet the requirements of GOST. In accordance with GOST 19285-73, one of the most important characteristics of kaolin, when used as a filler, is whiteness. The whiteness of kaolin is determined in accordance with GOST 16680-79 and is characterized by the content of coloring impurities in it - paramagnetic oxides of iron Fe2 O3 and titanium TiO2. Iron and titanium oxides are present in kaolin either in a dispersed finely dispersed state or as inclusions in kaolinite particles. And if iron oxides have a decisive effect on the whiteness of kaolin, then titanium oxides together with iron oxides give undesirable shades (gray, yellow) to fired porcelain products. Thus, by removing coloring oxides from kaolin, we increase its whiteness. To date, the most effective industrial method for purifying kaolin from coloring impurities is the method of high-gradient magnetic separation (VGMS) This method is highly energy-intensive and expensive, so alternative methods for increasing the whiteness of kaolin from the Eleninskoye deposit were considered in the work. At Novokaolin GOK, only selective ore mining is currently carried out, which is processed using a technology that includes: disintegration; classification according to the class of 500 μm; subsequent classification of fine material to class 200 μm; the small product is then sent for "active" classification according to the class of 63 μm; A small product is a marketable product with a mass fraction of 100% kaolin, and a large product (more than 63 μm) is sent for cleaning classification according to the class of 63 μm. A product with a particle size of more than 63 μm combines with a product larger than 200 and 500 μm, as a result of which they are beneficiation tailings, the loss of kaolin with which is about 30%. The existing technology has a number of drawbacks: processing only of areas of deposits with a mass fraction of 40% or more; a large number of classification operations that do not give high enrichment rates. The research carried out is aimed at improving the technology of enrichment of kaolin ores by processing any section of the deposit and reducing the loss of a valuable component.

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